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we never can tell to what such abstract speculations may lead, and that, in the end, they may give us something exceedingly valuable, either in the commercial world or in the realms of culture and knowledge. A comparison with prospecting may make it clearer. The miner digs day after day with apparently no return. He may continue to do so with no result, no matter how long he labors; but, on the other hand, at any moment he may unearth a rich vein which will more than repay him for his efforts. So it was with KEPLER, when he dug through TYCHO's observations day after day with no result, until finally, after much labor and the use of an enormous store of patience, he struck the vein of planetary motion, and his wonderful laws were brought to light. It was MICHAEL FARADAY who said so well, "There is nothing so prolific in utilities as abstractions."

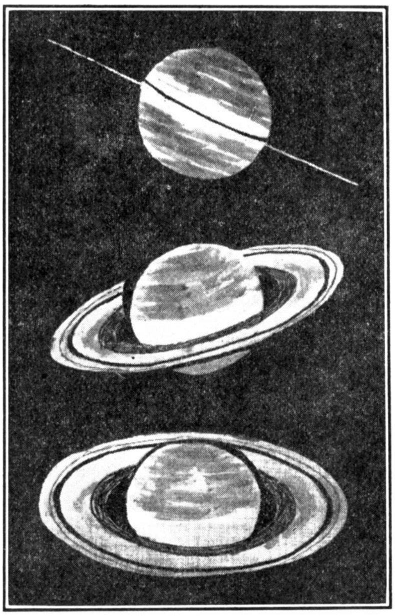
And now, in closing, I desire to express the hope that you who have heard what I have had to say, and those who may hereafter read what I have said, will ever feel it unnecessary to ask in inelegant English, "What is astronomy good for?"

BERKELEY ASTRONOMICAL DEPARTMENT, July 13, 1907.

THE LOST RINGS OF *SATURN*.

By ARTHUR B. TURNER.

The Moon long since became a dead world, without air or water. The planet upon which we dwell is well advanced in its development; its surface has cooled and hardened, but it still has air and water, the great life-giving elements. We look out upon the planet *Mars* with its surface covered by canals in the struggle of the inhabitants to get water to supply their needs. But beyond *Mars,* at a distance more than nine times our distance from the Sun, there circles a world, resplendent in the making, surrounded by satellites and rings, and taking over twenty-nine years to make its majestic swing around the Sun. This orbit formed the boundary to the solar system down to the discovery of *Uranus,* by HERSCHEL, in 1781. *Saturn* has a diameter a little more than nine times that of the Earth, and makes over two revolutions on its axis in one of our days. The result of such swift rotation is to make



the planet appear perceptibly flattened at the poles when viewed in the telescope. A vast envelope of clouds surrounds the fiery ball, which is light enough to float on water.

SATELLITES AND RINGS.

Ten moons swing around this globe, obedient to its attraction, the last one having been discovered by Professor W. H. PICKERING, of Harvard. The ninth satellite—*Phœbe*—is remarkable in the fact that it disobeys the ordinary laws of solar motion by moving backwards around the planet.

But the most remarkable feature of this world—distinctive from all other celestial bodies—is the wonderful system of rings, first discovered by GALILEO, and which appeared to him as bright stars on either side of the disk. He says of his discovery: "Looking on *Saturn* within these few days I found it solitary without the assistance of its accustomed stars, and in short perfectly round—are perhaps the two smaller stars consumed like spots on the Sun: have they suddenly vanished and fled? Or has *Saturn* devoured his children?" And so this old pioneer of astronomy died without realizing that what he had discovered was one of the greatest anomalies of the solar system. It was left for HUYGHENS, in 1655, to announce their true character.

There are three wide, thin rings surrounding the planet in the plane of its equator, and ranging from eleven thousand to eighteen thousand miles in width and about fifty miles thick. They are inclined to our path around the Sun, so that we see them at various angles as they reflect back to us the Sun's rays. It was thought at one time that they consisted of fluid or solid, but the mathematicians proved that such rings would soon fall to pieces, and that probably they consisted of swarms of particles like meteors, each particle following an independent path around *Saturn,* just as the Moon does around the Earth. By spectroscopic observations of the rings by the late Professor KEELER, it was shown that they must consist of discrete particles.

THE LOST RINGS.

The plane of these rings moves parallel to itself as they accompany the planet around the Sun, so that about every fifteen years this plane will pass through the Sun. The Earth in passing around the Sun will view the rings in varying positions. This year the plane of the rings passes through the Sun, and from April 12th to July 22d we face the unillumined side of the rings—the Sun being north and the Earth south of their plane. To us, then, the rings will appear as a black bar crossing the disk of the planet, with possibly a faint line of light where the rings extend on either side of the ball.

In 1891 the great Lick telescope failed to show any trace of the rings when in a similar position. From July 22d to October 4th the rings reappear as a narrow line of light on the two sides of the planet, as shown in the figure above. From October 4 to January 6, 1908, the Earth will be north of the plane of the rings and the Sun south of this plane, and the above phenomena will be repeated. It was this disappearing of the rings that so puzzled GALILEO.

When the rings are more favorably situated we can see the shadow cast on them by the planet, and also the disk shining through the inner dusky "crepe" ring.

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